Removal of Noise from Video Signals using Adaptive Temporal Averaging

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Abstract

This abstract proposed an algorithm for video denoising base on adaptive, pixel-wise, temporal averaging. This algorithm decomposes video signals into the set of 1-D time dependent signals and then removes the noise via establish the temporal averaging intervals during each signal from the set. Temporal averaging intervals established by simple, effective evaluation process which contain twoway thresholding. The proposed algorithm is experienced on quite a few types of 1-D signals and benchmark videos. Experiments advise that the proposed algorithm, regardless of its ease, produces highquality denoising results.

Index terms— signal processing, video denoising, temporal averaging, averaging interval, pixel-domain method

1 Introduction

ideo superiority enrichment is the long-standing and broad region of the research. Video signals are frequently impure by the noise all through attainment and transmission and noise is a governing factor that degrades the quality of the video signalsy. Low-end camera market is increasing fast (digital cameras, web-cams, cell phones etc.) and there is a necessity now more than ever for fast and effective and reliable video signal upgrading technologies to get better their output results. Even high-end and the proficient apparatus (surveillance cameras, medical devices etc.) contain to manage with video squalor and noise corruption (especially in extreme conditions). Nowadays, practically every video-capturing devices incorporates some kind of noise removal techniques. Video denoising is highly advantageous, not only for improving the perceptual quality, as well for the increasing compression speed and the efficacy and facilitating transmission bandwidth diminution. Most of the video denoising algorithms proposed in the literature consider an additive white Gaussian noise (AWGN) and that can be further divided into the pixel domain and transform domain methods. The Pixel domain methods can be subcategorized into spatial, temporal and the spatiotemporal domain methods and generally decrease noise by the weighted averaging. Majority of the recently proposed pixel domain algorithms is going to argue that spatiotemporal filtering method performs wellr than the temporal filtering, e.g. ST-GSM algorithm [1]. Nevertheless , spatiotemporal filtering, as well as the spatial filtering method, may significantly trim down theefficient resolution of the video signal due to spatial blurring **??**2]. Most video signals are temporally consistent and each new frame can be predicted from prior frames. If the two video signals are known with similar PSNR values, then one filtered with spatial method and the other with the temporal algorithm, the latter may be chosen just because of the temporal coherence. Motion information and the temporal coherence information can be included in the denoising algorithms of video signals throughout applying the advanced transforms [3,4]. However, most of the transform domain methods for video denoising be likely to be complex, sluggish, and not appropriate on end user electronics. Now the pixel domain temporal method of denoising algorithms also offers the ability of motion detection with the intention of conserve full resolution of the input image sequence signals and temporal coherence. But, even the pixel domain methods, which is used block-matching or similar methods, Frequently have need of lots of computer resources for the efficient noise removal. This paper proposes the pixel-wise temporal method for removing noise from video signals which is straightforward, spontaneous, yet effectual and competitive. This method observes video signals as group of 1-D signals -each video signal is decaying in m-by-n one-dimensional signals (m represents to width, and n height of image frame in numerous pixels) and then processed. This approach allows the algorithm to stay straightforward, quick and extremely adaptable. Removal of noise is achieved by an adaptive temporal averaging method applied on averaging intervals. This piece of writing intends to show that the high-quality of video denoising does not need the use of wavelet transforms, NLM technique of searching of related patches and other techniques (which are inescapably and inherently difficult). This paper shows a simple, easy and "lightweight" pixel-wise method for denoising video signals that can be produces high-quality noise removal results and even the out-perform of some of its more complicated competitors.

Experiments be conducted for testing the developed algorithms. The proposed algorithm is the first tested algorithm on a set of test 1-D signals that is degraded by additive white Gaussian noise and its results are used for the alteration of the algorithm. This algorithm is next evaluated with gray-scale benchmark video signals. The proposed method is offered in Section 2. Section 3 that contains experimental results and the conclusion element is existing in Section 4.

V Abstract-This abstract proposed an algorithm for video denoising base on adaptive, pixel-wise, temporal averaging. This algorithm decomposes video signals into the set of 1-D time dependent signals and then removes the noise via establish the temporal averaging intervals during each signal from the set. Temporal averaging intervals established by simple, effective evaluation process which contain twoway thresholding. The proposed algorithm is experienced on quite a few types of 1-D signals and benchmark videos. Experiments advise that the proposed algorithm, regardless of its ease, produces highquality denoising results.

Keywords: signal processing, video denoising, temporal averaging, averaging interval, pixel-domain method.

II.

2 Algorithm Proposed a) Model of Observation

Prior to examining the algorithm, the observation model and information used right through the paper have to be introduced. A noisy signal is measured:f [k] = s [k] + n [k] (1)

where s[k] is a noise-free signal and n[k] is the additive white Gaussian noise among zero mean and variance ? 2 (standard deviation ?). If the signal f[k] is a demonstration of time-dependent pixel concentration taken as of a monochromatic video signal then f **??**k] takes values between 0 and 255 and it has a limited number of the samples.

3 b) ATA Method

The projected method in this paper is the ATA (Adaptive Temporal Averaging) method. This method is based on a straightforward idea. A noisy input signal f[k] is considered, where the value of k = 1, 2, 3, ?, m. Noise is detached by establishing assessment intervals and applying averaging. Estimation intervals are recognized for each sample of the noisy input and each section of the resulting (noise-free) signal is obtained by means of the corresponding estimation/averaging interval of the noisy input.

The key to high-quality denoising is reliable estimation of the averaging intervals. This paper recommend the use of temporal coherence of the signals in order of the establish averaging intervals significance that each sample of a noisy input has a assured amount of related samples occurring instantly before and/or after it. If that is obtainable graphically (with time placed on the x-axis and the sample values placed on the y-axis), then each sample has a definite amount of alike samples residing instantly to the left and/or to the right. Groups of related samples are used for the forming the averaging intervals and an averaging interval is formed for every sample of the noisy input. Forming of averaging intervals is easy -ATA algorithm is comparing currently progression sample with successive samples to its left and the right side (comparison of the samples to the left and to the right are jointly self-governing). When the comparison procedure arrive at a sample to the left that is considerably different from the one at present processed, then that algorithm stops the left-hand side successive comparison. This is what how the left-hand part border of the averaging interval is obtains. The similar process is used for obtaining of the right-hand side border of the averaging interval. When its averaging interval is determined, then the estimation of the noisefree signals is obtained using by the mean value of the averaging intervals which as follows:

where e[k] is the estimated noise-free signal, l k is the left-hand-side and the r k is the right-hand side boundary of the averaging interval. A two-way threshold condition is used to establish boundaries of the averaging intervals. Even as determining boundaries of the averaging intervals, the algorithm examines complete differences between the sample that is being at present processed and samples residing to its left/right. When its examined, complete difference is greater than the pre-estimated value (which was named Threshold A), the boundary of the averaging interval is establish. Consecutively, the ATA method is cumulating the over mentioned differences. When that summation is larger than pre-estimated value (which was named Threshold B), the boundary of the averaging interval is found (refer to Figure **??**, that shows the algorithm flowchart). thus, two threshold criterion are liable for determining the boundaries of the averaging intervals (bear in the mind that the left-hand side boundary is totally independent from the right-hand boundary). Both the criterion are using consecutively, significance that the averaging interval boundary is determined by the one criterion which provides the averaging interval boundary first. Then the Threshold A is considered to react to immediate changes in the input signals and Threshold B is designed to respond to continuous changes in the input signal. Iterative methods were used for determining optimal values of the Threshold A and B -a variety of signals and videos were processed iteratively in anticipation of the best values of MSE, PSNR and SSIM were attained. With this approach, experiential optimal values for the Threshold A and the Threshold B were determined and that used in the further experiments. Which are as follows:Threshold A = 5??, Threshold B = 10??.

Removal of Noise from Video Signals using Adaptive Temporal Averaginge [k] = f [l k] + ...+ f [k] + ...+ f [r k] ,

(2) r k ? l k +1 r k ? k ? l k © 2017

4 Experimental Results

In experiments there were two 1-D signals were used to determine the efficiency of the ATA method. Also, several dissimilar gray-scale sequences were introduced for testing the algorithm: "Salesman", "Miss America", and the "Tennis". That were degraded with additive white Gaussian noise of a range of values of the standard deviation ? = 10, 15, 20 and processed with the projected filter.

5 a) ATA Method Applied on 1-D signals Two dissimilar test signals were used:

Both of the signals were degraded by the Gaussian noise of standard deviation ? = 10, 15, 20. This ATA technique was used for noise removal and the output results are articulated by determining the MSE (Mean Squared Error) of the noise removed signals (Table 1). Figures 2 and 3 exemplify denoising of Signals A and B using by the ATA technique. Through examining the output results that shown in Table 1 (along with the Figures 2 and 3), the conclusion is reached that the considerable noise removal is accomplished. Year 2017 This projected algorithm has been compared with the state-of-the-art noise removal algorithms for video signals, including the SEQWT [6], IFSM [7] and the ST-GSM [1]. To be the better place the performance estimation in the context, the one baseline algorithm has also been incorporated in comparison; still the GSM [8]: static image GSM denoising technique applied on a frame-by-frame basis. Then the values of PSNR and SSIM obtained by the ATA technique and comparison to the other state-of-the-art techniques are enclosed in Table 2. In the shown figures 4 and 5 denoised frames of the video signals "Salesman" and "Tennis" are shown along with the original and noisy frames also for comparison. Then the evaluation shows that the amount of the noise removed is significant and the ATA technique is the highly competitive than others when compared to state-of-the-art noise removal algorithms.

6 IV.

A simple, easy and intuitive method is projected in this paper, yet highly competitive video denoising technique based on determining averaging intervals. This method exploits video's temporal coherence to attain the averaging intervals by effortless two-way thresholding designed for create the averaging interval's on left-hand side and also on the right-hand side boundaries. Removal of noise is done by applying Year 2017

7 F b) ATA Method Applied on Image Sequences

A number of dissimilar gray-scale sequences were used to determine the method performance. For the easy and simple comparison with the existing algorithms, and the noise standard deviations are selected to be 10, 15 and 20, correspondingly, and only the output results of the luminance (Y) channel are accounted. Thus the Peak signal-to-noise ratio (PSNR) and the structural similarity (SSIM) index [5] are to be used to provide the quantitative estimations of the algorithm. Then the latter has been shown to be the better indicator of the perceived image-sequence quality [5].

8 Conclusion

Fig. **??**: Denoising of video "Salesman" corrupted with noise ? = 20 using ATA method, frame 100; from left to right: original, noisy, denoised. [6], IFSM [7] and still GSM [8]. This projected algorithm is simple and easy to use and doesn't involve more complex video denoising actions which are numerically more demanding. Further improvements of the proposed scheme are feasible and desirable, especially taken into accounts that ST-GSM [1] technique is still capable to generate somewhat improved denoising results. Improvements will be explored not only the considering efficacy of the projected technique but also of its speed. In the upcoming research will be focus on the enlargement of more complicated and more consistent threshold criterion for determining boundaries of the averaging intervals, which will facilitate enhanced and faster performance of the technique. [1] [2] [3]

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[2] © 2017 Global Journals Inc. (US)

[3] . Zlokolica, V., Pizurica, A., Philips, W.: Recursive temporal denoising and motion estimation of video,

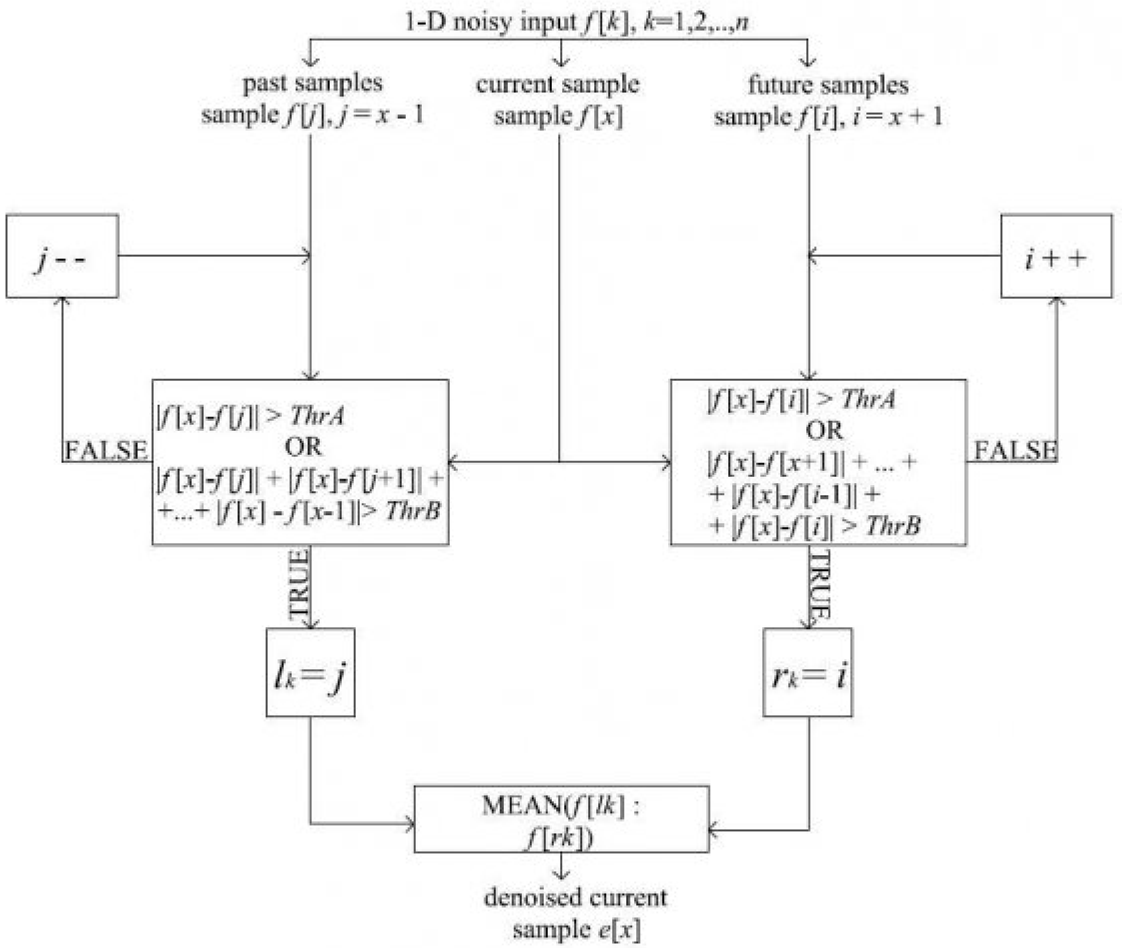

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Figure 1: 2017 FFig. 1 :

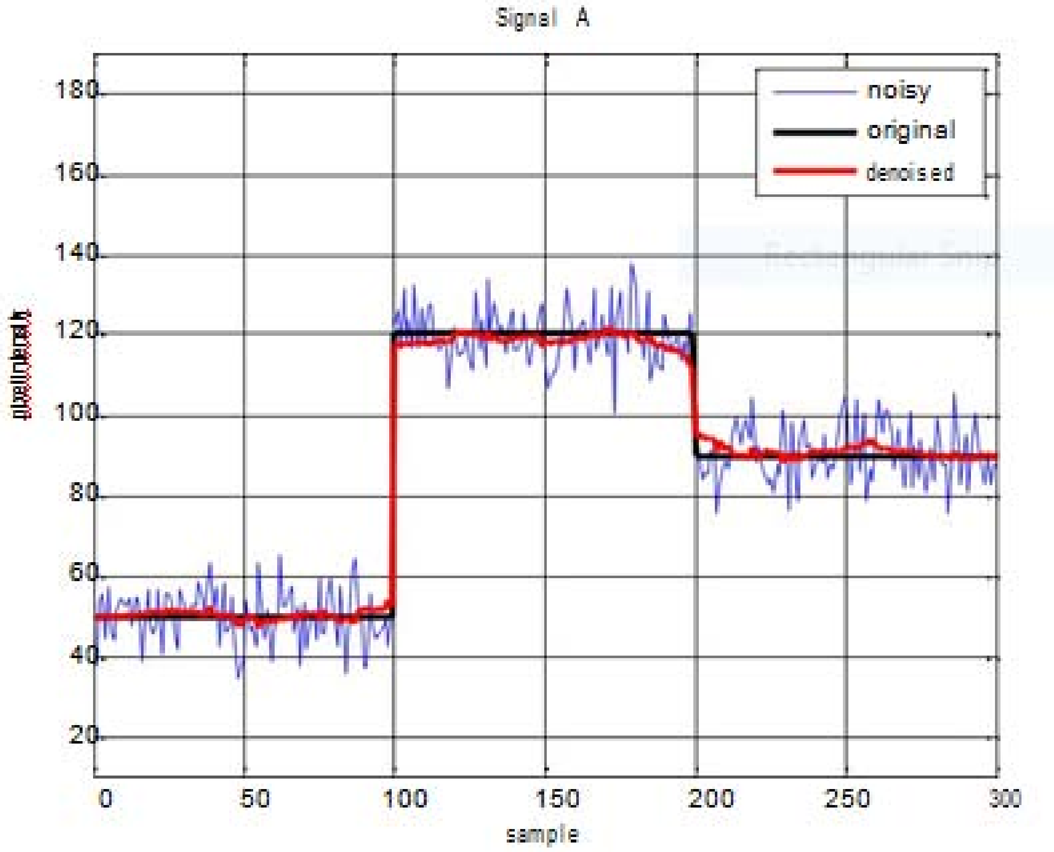
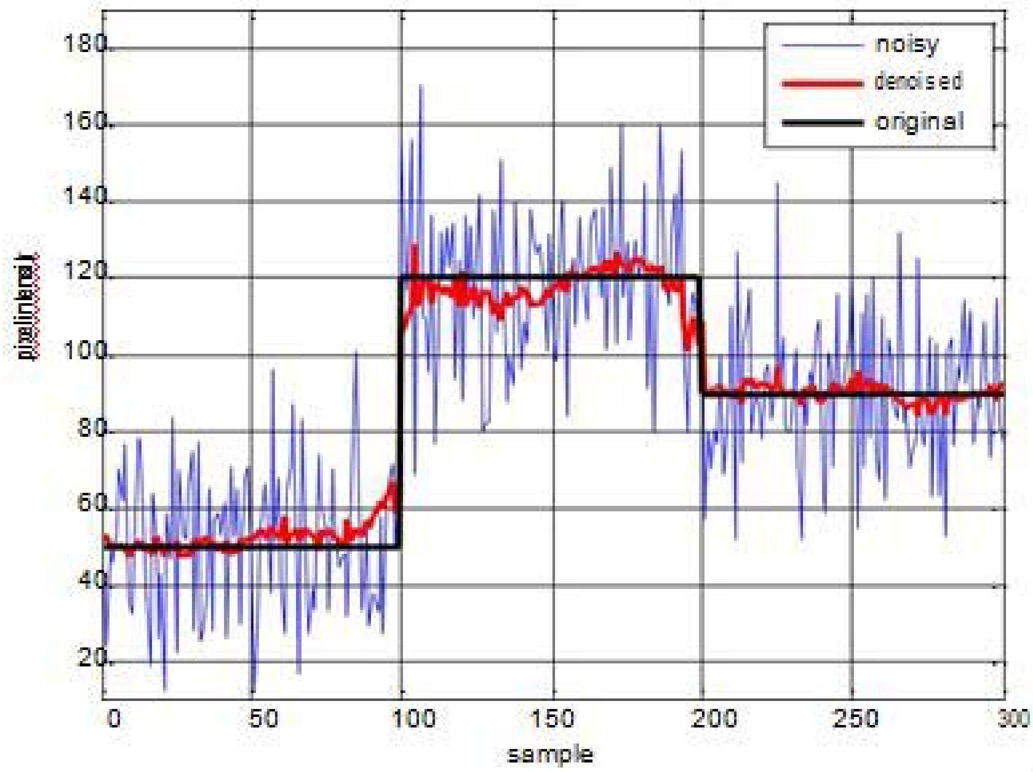
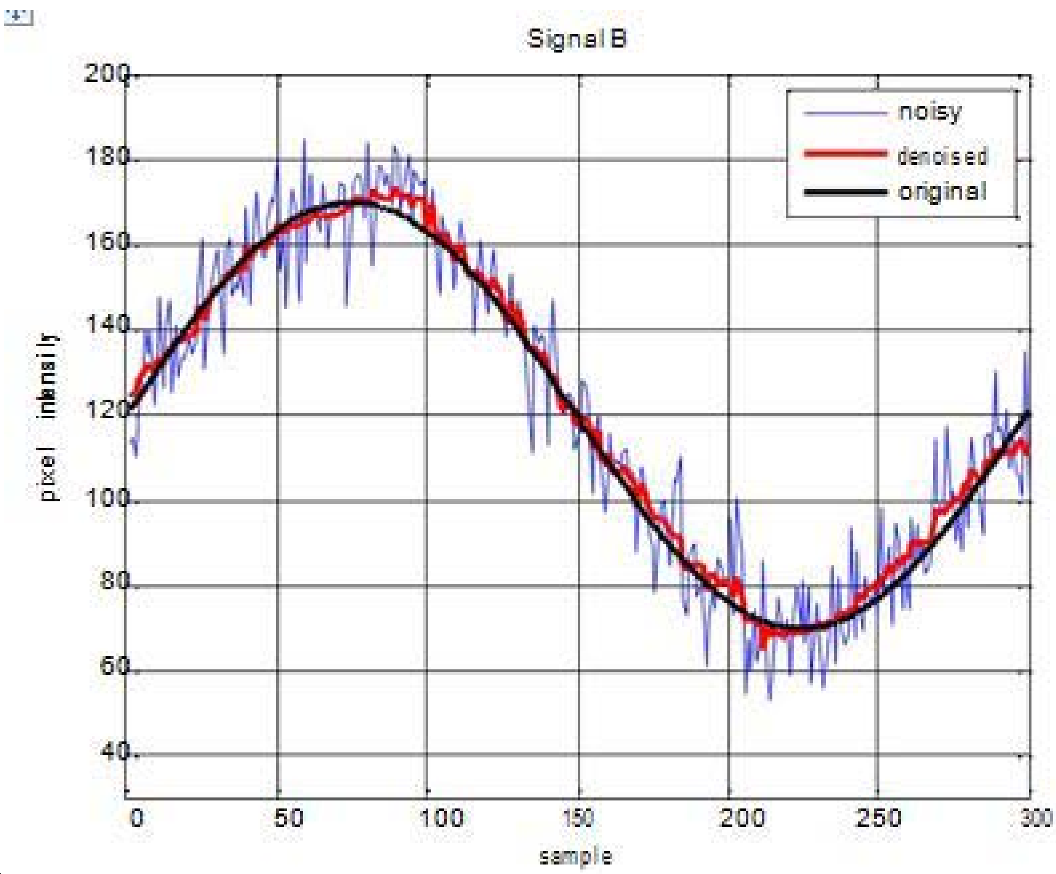

Signal A
noisy
original
denoised
180
160
140
120
100
80
60
40
20
0
50
100
150
200
250
300
sample

Figure 2: F-



2 □

Figure 3: Fig. 2 :



3

Figure 4: Fig. 3 :

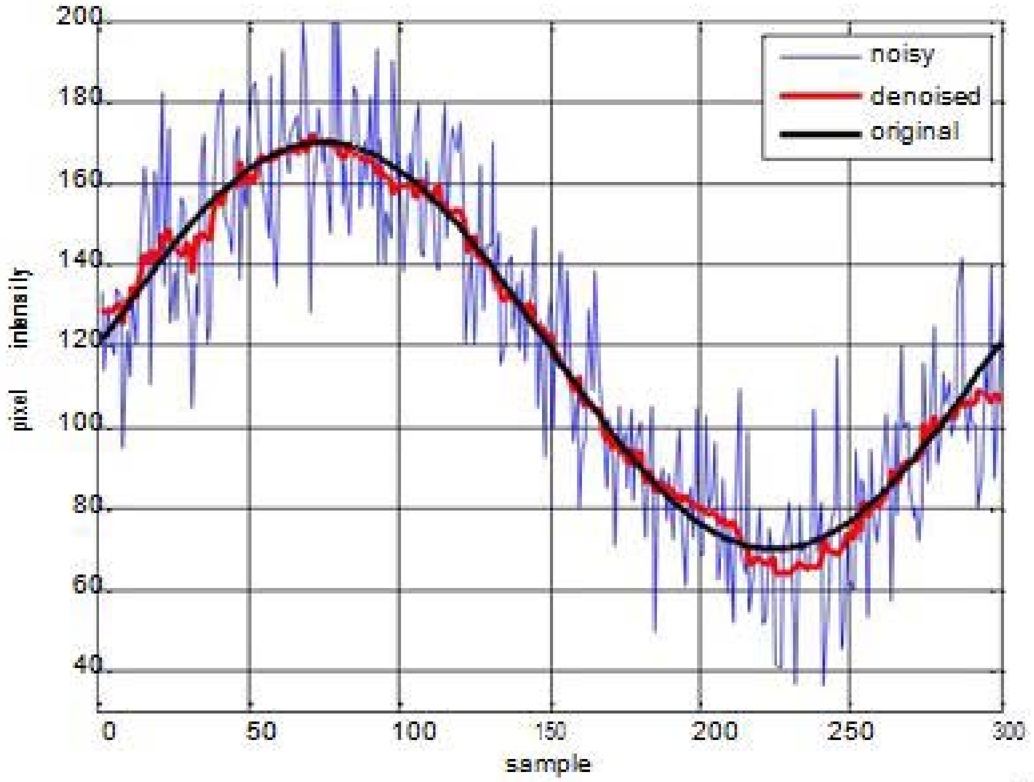


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Figure 5: Fig. 5 :

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Figure 6: Year 2017 F

1

Noise ?	10	15	20
		MSE values	
Signal A	2.917	3.038	21.488
Signal B	9.150	10.361	13.180

Figure 7: Table 1 :

2

Video		"Salesman"		"Miss America"				"Tennis"	
Noise ?	10	15	20	10	15	20	10	15	20
				PSNR [dB]					
Noisy	28.16	24.72	22.32	28.15	24.62	22.29	28.22	24.72	22.25
SEQWT [6]	32.86	30.59	29.09	NA	NA	NA	31.19	29.14	27.59
IFSM [7]	34.22	31.85	30.22	37.52	35.41	33.86	32.41	30.10	28.56
still GSM [8]	33.80	31.73	30.28	38.52	37.14	36.14	31.82	29.87	28.65
ST-GSM [1]	38.04	36.03	34.61	40.57	39.40	38.50	34.05	31.97	30.59
Proposed	35.64	33.78	32.51	37.16	35.77	34.30	32.95	30.55	28.72
				SSIM					
Noisy	0.718	0.574	0.467	0.493	0.321	0.226	0.719	0.573	0.466
SEQWT [6]	0.900	0.846	0.796	NA	NA	NA	0.842	0.772	0.716
IFSM [7]	0.904	0.851	0.801	0.904	0.857	0.812	0.855	0.776	0.709
still GSM [8]	0.909	0.865	0.825	0.936	0.922	0.913	0.831	0.758	0.711
ST-GSM [1]	0.960	0.941	0.923	0.952	0.943	0.936	0.894	0.841	0.797
Proposed	0.941	0.920	0.899	0.910	0.884	0.861	0.870	0.813	0.756

Figure 8: Table 2 :

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